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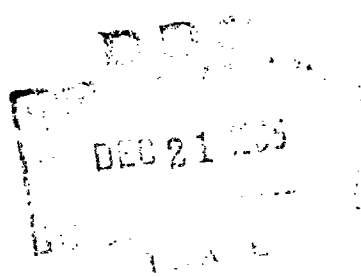
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INTRODUCTION

While I have had a continuing interest in what might be called the economics of medical care and medical research, it is only in the last couple of months, at the urging of Mr. Henry Rowen, of the Bureau of the Budget, that I have renewed my concern with this area in a more active way.

What I would like to cover in this talk are my views as to the state of relevant research on the problem of cost benefit analyses in the health area, and more particularly to discuss the likely nature of cost benefit analyses of Federal Government programs in the health area. Current efforts within the government are likely to be more concerned with the practical problems of introducing program budgeting. Cost-effectiveness studies will come later. Nonetheless since this later set of problems is more in my line, the bulk of the paper will be devoted to exploring what seems to me to be the likely requirements, difficulties, and opportunities for cost-effectiveness studies in this area. What is to follow can be divided into three parts: First, a review of some of the relevant work of economists and others that concern themselves with costs and benefits in the health area. This portion of the talk will concern itself mostly with the economists who have been mainly interested in the economic implications of improved health. Second, I would like to go over a BOB-prepared example of a

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This talk was given at Monterey, 10 November 1965, to a special session of the Defense Management Systems Course sponsored by the Bureau of the Budget. Attending the four weeks course were personnel from many United States Government Departments and Agencies attempting to introduce program budgeting and cost-effectiveness methods.

program budget for health programs administered by HEW as a framework within which to go on to discuss possible types of cost benefit analysis that might be undertaken of these programs. Third, I would like to close with a discussion of what appear to me to be main problems and opportunities for cost benefit analysis in the health area.

#### A REVIEW OF RELEVANT RESEARCH

I would like to discuss two sorts of research: First, very general research on the economic value of human beings; second, particular calculations that have been attempted of the cost and benefits of the eradication of specific diseases.

In the past there have been many attempts made by economists, statisticians and actuaries to estimate the economic value of human beings (a problem that comes up repeatedly in military problems, safety programs of all sorts, etc., as well as in the health area).

The list of such attempts begins with that of Sir William Petty in the late 17th Century, and runs through an illustrious list of names in the field of economics and population statistics: Smith, Farr, Giffen, Marshall, and, more recently, some of the people involved have been Schultz, Becker, Weisbrod, and Mushkin. The recent interest within the Economics profession is more concerned with the importance of investment in human capital and its relative neglect in earlier economic studies. Much of the earlier interest of the economists has been stimulated by the large manpower losses to European countries in World War I, by economic policy consideration relating to immigration restrictions (European emigration in the last century and early part of this century being equivalent to high death rates in twenty years and above age groups), public investment in training and education of children, and more recently, the effect of decline in death rates and possible economic return from investment in health. When concerning themselves with cost benefit analysis in the health field, economists often point out that health is a consumption good as well as an investment good; that is, that both personal expenditure on health and presumably government policy in investment in the area of health is not only to be judged in terms of the increased earning

capacity of the individuals, but also in the equality of life that they are able to lead. Indeed, medical services are probably more often demanded because of a desire to reduce the everyday aches and pains of life, which affect individual earning power little if at all, than for the treatment of the fatal diseases that economic calculations have been largely confined to. Most economic calculations of the value of human beings are used to determine the value of preventing a death at a particular age among the members of the working population, by estimating the capitalized value of the average future stream of earnings of a person in that age group. Such calculations relate to only one aspect of the payoffs from investment in health.

Let me quote Professor Klarman in this connection:

CONSUMER BENEFIT: A common difficulty in measurement is that few (if any) health services are pure investment goods or consumption goods that yield the same degree of health improvement. It is conventional to recognize the benefit in consumption derived from most health and medical care expenditures (such as reduction of pain, discomfort, etc.), to comment on the difficulty of measuring it, and then to dismiss it. What receives weight (and space) is what is measurable; and that is not necessarily important. Since the measurable segments--output loss and medical care expenditures--are not equally important in all programs being evaluated, their sum is not likely to bear a consistent relationship to the loss of consumption benefit. Attaching a value to the latter, lest it be forgotten (or treated as zero), is both a sobering and challenging task.

For this purpose it is helpful to recall that consumers are frequently willing to incur expenditures, medical and other, that do not promise an increase in earnings or an offsetting saving in expenditures. Suppose a person's lifetime income were guaranteed to him and his heirs, and health and medical services were furnished free of charge. Notwithstanding, would not many persons be willing to spend some money to avoid syphilis or to be cured of it in the early stages? It seems plausible to assume an affirmative answer. The question is, how much would they be willing to spend?

Good sources on this broad area are "Health as an Investment," Thelma J. Mushkin, The Journal of Political Economy, Vol. LXX, Supplement: October 1962, pp. 129 through 157; and The Economics of Health by Herbert E. Klarman, Columbia University Press, New York, 1965.

For more specific calculations with respect to particular diseases I would suggest looking at Herbert E. Klarman, "Syphilis Control

Programs" in Measuring Benefits of Government Investments, Robert Dorfman, Editor, The Brookings Institution, 1965; and the Economics of Public Health by Burton A. Weisbrod, University of Pennsylvania Press, 1961.

In order to show some of the considerations that would have to go into cost-effectiveness studies of investment in improved treatment of specific diseases, as well as to allow an opportunity to criticize some of the kinds of calculation which are produced by groups urging the adoption of specific health programs, I would like to turn to the discussion of some calculations of the cost and benefits of a national program to conquer heart disease, cancer, and stroke, included in the Report of the President's Commission on Heart Disease, Cancer and Stroke, February 1965. Details of these calculations occur in Volume II of that report. I am not here entering into the pros and cons of the particular program suggested, but merely criticizing the calculations presented to show the economic costs of these particular diseases. To pick one, just as an example, this report estimates that in the year 1962 cancer cost the United States \$11.2 billion. This represents a direct cost of medical services during that year of \$1.2 billion, and an indirect cost of \$10.0 billion. This latter estimate is based on the notion that if cancer had been totally eradicated sometime in the past, and in the calculations I believe the year is 1900, a good many people who had died in the past would still be in the work force. The additional number of people in each age group multiplied by the average earning in that age group summed over all age groups is used to obtain an estimate. This comes to \$9.0 billion for cancer, the remainder of the indirect costs are due to morbidity.\* This sort of calculation is used to show how important economically this and the other diseases are and to form some basis for arguing for investment in measures leading to improved care.

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\*For comparison, Weisbrod, using the more usual method of calculation based upon the sum of the discounted stream of future earnings, gives an estimate of the loss due to cancer in 1954 of about \$2.6 billion per year (using 4 per cent discounting rate).

Let me review some of the things that this type of calculation has left out. First, depending on the nature of the improved treatment involved, not all of the direct costs could be saved. Unless it would be possible to prevent cancer from ever occurring, there will be costs of treatment. In fact, improved care might be much more expensive than current treatment, or possibly much cheaper. The point is one needs an estimate of treatment cost. On the other hand, by looking only at the costs of a particular year, one is underestimating the possible benefits of obtaining a cancer cure. In the health area as elsewhere cost effectiveness calculations involve comparing the whole stream of benefits, discounted back to the point at which decisions are being made. Presumably in more realistic calculations, what would occur as a result of medical research, or the employment of improved method of care, is not a dramatic shift of the cancer death rate from whatever it is to zero, but a gradual decline at some rate over lengthy period. This gradual decline and the discounting the future benefits would mean that the close-in benefits are likely to be small while the larger future benefits are heavily discounted. Moreover, there is a problem as to future wage rates, assuming significant increase in the working population, but this would in any case be itself a difficult projection to make (moreover the retirement age might be younger in the future). In the calculations being criticized here, it is assumed that something like six million additional people would have been in the labor force.

With respect to cost, the discounting procedure, if the costs have occurred in the past, of course, has the effect of inflating them. Thus, in the current case, where it is assumed that somehow the cure for cancer was found prior to 1900, R&D expenditures in the 1880s and 1890s, if accumulated at approximately 5 per cent as a basis of comparison with current presumed benefits, would be very large. Even if one assumes that the R&D program was especially successful, short-lived, and occurred immediately prior to 1900, an interest rate of 5 per cent would mean that any R&D expenditures ought to be multiplied by a factor of 22, when being compared with the yearly benefit. Of course, again what this expenditure has to be compared

with is not the single year, but the whole sequence of benefits which would have been rather small in the early part of the century. What one ought to compare is something like:

$$\text{Cost} = \int_{-T}^{1900} R\&D(t) e^{-\alpha t} dt$$

$$\text{Net Benefit} = \int_{1900}^{\infty} [GNP^*(t) - GNP(t)] e^{-\alpha t} dt$$

where  $GNP^*(t)$  takes account of any reduction of capital stock caused by diversion of investment to incremental treatment expense--to prepare such an estimate would be an interesting economics problem in itself.

In the literature there is a dispute over whether to deduct subsistence from earnings in calculating the value of saving lives. Some suggest it is not appropriate in the United States, but ought to be done for underdeveloped countries with excess population. The use of earnings would be correct, however, if  $GNP^*(t)$  can be calculated since it would take account of changes in the labor capital ratio implied in increased investment in health.

As a summary of my reactions to the existing literature that deals with estimates of the cost of disease or with cost-benefit calculations in the health area let me say:

1. While a start has been made in thinking through the rationale of such estimates and calculations actual estimates and calculations of costs and benefits are seriously incomplete in most cases and often are wrong in principle.

2. With respect to estimates of benefits it is especially important that: (a) some means be found to reflect the consumption value of improved health (as contrasted to the sole use of the dollar value of increased labor force participation as a measure of the payoff to improved health), (b) more realistic reflection of the real options

open to investment in better health be included in estimates (e.g. relating expenditures on alternative programs of medical research, training, improved facilities, etc., to future rates of decline in mortality at morbidity rates) since complete eradication of most diseases is not a realistic option; the problem for health policy is to choose among alternative possible improvements, the current cost of specific diseases is largely irrelevant.

#### PROGRAM BUDGETING OF GOVERNMENT HEALTH PROGRAMS

Total health expenditures in the United States are running about 6 per cent of GNP, or at a level of \$35 to \$40 billion. Total government expenditures in the health area are approximately \$5 to \$6 billion. Over the past decade, the government has been assuming an increased role in the health area. Through the expenditures of the National Institute of Health, now about \$1.1 billion and doubling approximately every four years, it now dominates the medical research area. It is involved in major programs supporting hospital construction, the Medicare Bill passed just recently, and it seems likely that this trend will continue.

However, in contrast to Defense, where the Government, so to speak, owns the problem, the U.S. Government does not spend more than about 15 per cent of the total expenditure on health and medical care each year. Thus many government programs have to be looked at as supplements or as subsidies to private programs. Hence, in some of the government programs there will be serious problems in evaluating their effectiveness, because there will necessarily be uncertainties as to how the nongovernmental portion of market will in fact react to, or take advantage of, various government programs. But let us look in more detail at a part of the U.S. Government's health expenditures, those included in the Department of Health, Education and Welfare, with the objective of (a) presenting a tentative program budget of these expenditures, and (b) discussing some of the kinds of cost-effectiveness studies that might be useful in evaluating programs within the context of this program budget.



The following sample program budget for health was prepared in the Bureau of the Budget as an example, and for preliminary guidance to HEW in coming up with a proposal of its own. This will indicate some of the kinds of programs HEW is currently involved in, and the likely cost benefit analysis issues that may occur later. This program budget covers only those parts of the government health expenditures administered by the Department of Health, Education and Welfare, and therefore covers approximately \$2.5 billion, or about half of the U.S. Government health expenditures. Most of the remaining government expenditure is in the DOD and Veterans' Administration budgets. This sample program budget has six main headings: (1) Provision of Health Services; (2) Improvement in Quality and Organization of Community Services; (3) Research; (4) Health Protection and Prevention ; (5) Environmental Protection and Control; (6) General Support. The listings in parentheses are indications that portions of the funds now budgeted in specified programs or types of expenditure would probably be included in the designated program package.

A PROGRAM BUDGET FOR HEALTH (HEW)

I. Provision of health services

A. Specific beneficiaries

1. Migrants  
(Community health practice and research)
2. Merchant seamen and Coast Guard  
(Hospitals and medical care)
3. Indians  
(Indian health activities  
(Construction of Indian health facilities)
4. Dependents of uniformed service personnel  
(Retired pay of commissioned officers)

B. General beneficiaries

1. Aged  
(Grants to States for public assistance)  
(Medicare)  
(National Institute of Child Health and Human Development)  
(Chronic diseases and health of the aged)
2. Children and maternal  
(Grants for material and child welfare)  
(Children's Bureau)  
(Improvement of medical care for needy children)  
(Communicable disease activities)  
(National Institute of Child Health and Human Development)
3. Needy  
(Grants to States for public assistance)

C. Special services

1. Mentally ill  
(NIMH)  
(Community mental health centers)  
(St. Elizabeths Hospital)  
(Hospitals and medical care, PHS)
2. Mentally retarded  
(Grants to States, VRA)  
(NIMH)  
(Health research facilities construction)  
(NICH and HD)  
(Chronic diseases and health of the aged)  
(OASI benefit payments)  
(Grants for maternal and child welfare)  
(Children's Bureau)  
(Bureau of Family Services)  
(Grants to States for public assistance)
3. Tuberculosis  
(Control of TB)
4. Rehabilitation  
(Grants to States, VRA)  
(Chronic disease and health of the aged)

II. Improvement in quality and organization of community services

A. Training

1. Doctors

(Community health practice and research)  
(NIMH)  
(Defense educational activities, OE)

2. Dentists

(Community health practice and research)  
(Dental services and resources)  
(Defense educational activities, OE)

3. Nurses

(Nursing services and resources)  
(Community health practice and research)

4. Paramedical

(Expansion and improvement of vocational education, OE)  
(Chronic disease and health of the aged (cancer technicians))

5. Other professional health personnel

(Research and training, VRA)  
(Community health practice and research)  
(optometrists and other public health personnel)

6. Research training

(NIH, Community health, and Environmental health appropriations)

B. Physical resources

(Construction of health education facilities)  
(Construction of community mental health centers)  
(Hospital construction activities)

C. Improvement of quality and organization

(Heart, cancer, and stroke (medical complexes))

III. Research

A. Conduct of research

(Salaries and expenses, FDA)  
(Chronic diseases and health of the aged)  
(Communicable disease activities)  
(Community health practice and research)  
(Control of TB)  
(Control of VD)  
(Dental services and resources)  
(Nursing services and resources)  
(Hospital construction activities)  
(NIH)  
(Scientific activities overseas)

B. Research training

(Injury control)  
(Chronic diseases and health of the aged)  
(Community health practice and research)  
(Dental Services and resources)  
(NIH)

C. Construction of health research facilities

IV. Health protection and prevention

1. Communicable diseases  
(Communicable disease activities (yellow fever))  
(Control of TB)  
(Control of VD)
2. Injury control
3. Emergency health activities
4. Regulation and inspection  
(FDA)  
(Foreign quarantine activities  
(Environmental engineering and sanitation)
5. General Support  
(NIH)  
(Injury control (research))  
(Chronic diseases and health of the aged)  
(Communicable disease activities)  
(Community health practice and research)  
(Control of TB)  
(Dental services and resources)  
(Nursing services and resources)  
(Hospital construction activities)

V. Environmental protection and control

1. Water pollution  
(Water supply and water pollution control)  
(Grants for waste treatment works construction)
2. Air pollution
3. Radiological health
4. Occupational health
5. Other programs  
(Environmental health services (Arctic health center))
6. General support  
(Environmental engineering and sanitation)  
(Air pollution)  
(Environmental health sciences)  
(Occupational health)  
(Radiological health)  
(Water supply and water pollution control)

VI. General Support:

- (National health statistics)
- (National Library of Medicine)
- (Retired pay of commissioned officers)
- (S&E, Office of the Surgeon General)

### PROBLEMS OF COST-BENEFIT ANALYSIS

The rationale of the grouping in this program budget is to put together programs which have similar objectives. However, it will probably take a good deal of work if anything like this program budget is adopted to apportion the expenditures as passed by the Congress into the above specified program packages. The rationale of putting similar programs together is not only that they have the same general objectives, but also that one is likely to be interested in tradeoffs as between different programs in the same program package.

This again is where one comes up against the problem mentioned earlier. The Defense Department has the whole job of defending the United States, which makes it an interesting question in the Defense Department Strategic Offensive Forces Package to talk about tradeoffs between Polaris, Minuteman, etc. The responsibility of the Government in the health area is not that comprehensive; therefore in Package 1 of the health program budget it's not clear that one is interested in trading-offs between programs to supply medical care to migrants, merchant seamen, Indians, etc. These are merely particular groups that the Government has inherited a special responsibility for. It would seem to me that the kind of cost-effectiveness studies one might do in these areas would relate to evaluations of effectiveness in particular programs. For example, studies designed to compare the cost of medical care per person in each of the programs.

For Package 1 my guesses as to the most rewarding cost benefit analyses are:

1. Studies of the efficiency of current medical care programs, and the evaluation of alternative modifications of these programs.
2. Analysis of the objectives of maternity and infant care programs since:

Infant mortality is already very low. We are now trying to save more and more difficult cases (e.g. blue babies and defective children of all sorts) which gets harder and harder leading to rapidly decreasing marginal returns. (In any case, one should examine these programs to see to what extent the

main barriers to reasonable improvement in infant death rates are not related to attitudes and resources of special minority groups).

In the Package 2 area, Improvement in Quality and Organization of Community Services, the objectives of the programs are to assist in the training of medical personnel, to upgrade the type and quantity of medical services available to the community. Here I would think that there are some interesting questions to study as to the balance among the various kinds of training being sponsored -- nurses vs doctors vs paramedical, etc. Given salary scales for doctors, dentists, nurses, and all other medical specialities (assuming that these reflect the demand for these personnel) and estimates of the effectiveness of government expenditure in increasing the supply of these personnel, it would be possible to look at the optimal balance of expenditures as amongst all of these types of training.

With respect to hospital construction, cost benefit studies of hospital programs could be carried on so as to get optimal effectiveness from the construction funds. Moreover, there are problems of coordination and reconciling the way in which two or more government programs interact. It is alleged that studies of the geographic distribution of (a) the increased demand for hospital services implied by the Medicare Bill and (b) the increased supply likely to result from the Hill-Burton hospital construction bill do not coincide very well. This is an area where analysis might indicate how to get more efficient use of the hospital construction monies.

Adding hospital beds does not necessarily insure that they will be in fact used. Indeed, there is a possible tradeoff between programs designed to increase the supply of hospital services available and other programs designed to increase the effective use of existing hospitals. This is only one aspect of a very general problem. A medical friend of mine conjectures that the single most cost-effective program in the United States today would be one designed to get more people into the hands of the medical profession and out of the hands of chiropractors, healers, quacks, fortunetellers. That is, there is

at this moment likely to be more payoff in getting more people into the habit of using the average competence of current trained medical practitioners than in upgrading the training and capabilities of the trained medical profession.

The final item in this general package containing programs designed for Improvement of Quality in Organization, is exemplified by the Heart, Cancer and Stroke program. This is representative of a type of program which should become considerably more numerous, more important and a larger part of the U.S. government health budget in future years. The United States is currently expending a major effort in the area of basic medical research. Let me stress that most of the research is basic research. Most of it is not specifically disease-oriented, but related to understanding biological processes. The notion being that at a later time the knowledge obtained will allow the development of effective treatment of the major diseases. Those in charge of the NIH program assert that this is the preferred strategy of attack at the moment. If this program is successful, at a later time it will be necessary to go on to study how best to apply this knowledge to the prevention, cure, treatment of specific diseases. At this stage, what might be thought of as the development stage in military R&D terminology will have been reached. Once that stage is reached, one will want to know how to best allocate the development money. Which diseases should be emphasized? Some notion of the economic importance of various diseases and public preferences to be protected against one disease rather than another would be relevant in choosing. It is easy to imagine that the public would desire to avoid, if possible, especially disfiguring or painful diseases even if they did not currently have much effect on potential GNP. Some way must be found to reflect such preferences in any cost-benefit studies designed to assist in the allocation of funds for the development of improved treatment of various diseases. But it will be important that the solicitation or measurement of public preferences be undertaken in a systematic and reflective way, since the history of much public support for the care and treatment of specific diseases appears to me to have had a large element of sentimentality in it as

the result of publicity campaigns by specific groups interested in particular diseases.

Another potential area of study might concern itself with the problem of the best way to introduce newer methods of treatment, better techniques, etc., to the medical profession at large. Thus, for example, in the case of the Heart, Cancer and Stroke Programs, a study might be undertaken of a variety of programs before making the decision as to the most cost-effective program. Each program might be designed on an equal cost basis and judged for effectiveness in terms of the degree to which it was likely to improve the quality of medical care throughout the country. There clearly would be a number of criteria problems (e.g., How is improved quality of medical care to be measured?). In some cases, one could try to do it directly in terms of estimated improvement in death rates, morbidity rates for particular diseases, by area.

One thing I note in the health area is a reluctance to make estimates of important technical parameters, payoffs, costs, that are necessary to any evaluation of the total cost or benefit of specific programs. For example, the cost-benefit analysis in the health area I have seen, often mentioned the desirability of including such-and-such an effect or factor in the evaluation of the cost or benefit of a particular program, but they rarely, if ever, include quantitative estimates of these aspects. Of course it can be claimed that the effects of specific programs are very uncertain and therefore it is difficult to make the required estimates. No doubt it is, but so are many similar estimates in the defense field difficult to make. The degree of uncertainty may determine the nature of the estimate that is made, for example making several estimates that span the likely outcomes, or a most probable estimate together with an optimistic and pessimistic case. Also efforts are made in the designs of defense studies to make them as insensitive as possible to the relevant uncertainties, perhaps by considering several assumptions and presenting to the decisionmaker the range of possible outcomes, on the basis of which he can make a judgment as to the best program to adopt, or it may be possible to construct programs that are less sensitive to



the relevant uncertainties. Nonetheless it would seem to me that active efforts to try to make the appropriate estimates should be undertaken, before one simply throws his hands up in the face of uncertainties. Uncertainties, like diseases, should be treated not ignored. But, in fact, I know of no study which even tries to make these sorts of estimates. Cost-Benefit studies in the health area will probably have to set new standards of bravery before they are useful to government decision makers.

In any case, I would think of this area, that is of investment in demonstration centers, in other devices to get the results of medical research and development into use in community medical practice as soon as possible, would be an area of increasing Government concern. If only because it may well be required to make sure that the expenditure on basic medical research really has an adequate payoff. In this connection, it would be extremely interesting to have some studies started of how innovation in medical treatment now takes place, how long it takes, what are roles of the medical schools, leading hospitals, the drug companies, etc.? Unless one has some notion of how this process operates, perhaps how it could be improved, it will be difficult to do the kinds of studies I have been suggesting, on the terminal stages of medical R&D.

With respect to the research category, I have already indicated the main points. First, that the research, at least as conducted in HEW, is largely basic research, which makes it very difficult to look at the payoffs of one research project vs another. Basic research has not been an area where cost-benefit studies have been able to give guidance with regard to allocations of funds. There is no reason to expect basic medical research to be different in this regard. Second, that in the future it might be the case that as the basic research produces results more applied research may be undertaken leading to the development of new methods of medical treatment, equipment, and so on. It remains to be seen what role, if any, the Government will play in some of these later stages. But it would not seem unreasonable to expect to see the Government play a major role in this phase as well as in the basic research phase of medical research.

Section IV "Health Protection and Prevention" contains a variety of programs relating to regulation, inspection, quarantine activities, specific programs for the control of yellow fever, TB, venereal diseases, etc. Here again, it seems to me that the Government's programs are only a small part of the health protection and prevention measures taken in the country, and that one may well be confined to studying the activities for the particular programs and evaluating them on a cost-benefit basis. With regard to some of the communicable diseases; for example, yellow fever and the attempt to eradicate the *Aedes aegypti* mosquito, some interesting questions may be posed as to judging alternative programs and their promise for achieving the objectives of these programs. The second observation I would have is that in a number of these cases, attempts are being made, essentially to get the probability of contracting specific diseases down to zero. This always poses an acute problem, since, as the probability approaches zero, it becomes increasingly hard to measure, and increasingly difficult to assess the marginal value of specific changes in enforcement or other measures. This suggests some real thought of how to go about these programs, and what is the best measurement of the effectiveness of programs for eradication or social prevention of specific diseases.

Again this is a very general problem: How far to try to go in trying to eradicate a particular disease? In the case of plague, we have to live with an environment which provides sources of infection and control the cases that occur. It would be too costly to reduce the probability of a plague case to zero through destruction of all host rodents. A cost benefit approach to this type problem which displayed the tradeoffs involved in specific programs between prevention and treatment would be interesting.

With respect to the next category of environmental protection and control, there would seem to be a number of interesting opportunities. At least those of us who live in places like Los Angeles are quite aware of the air pollution problem. There are large social and economic problems relating to water pollution, air pollution;

methods of evaluating and designing programs in these areas on a cost benefit basis need to be developed. Special attention should be given to tradeoffs involved in these areas when these problems are examined in broad perspective. Not only do new technologies need to be considered in reducing the pollution problem, but as the recent PSAC report on the pollution problem suggests new taxation -- incentive schemes may be needed. In any case these broad environmental problems need to be looked at in their broadest perspective and on a systematic basis.

#### FINAL COMMENTS

I have tried to indicate some of the areas in which cost-benefit analyses seem most promising and some of the major problems likely to arise in doing such analyses in these areas. I am impressed by the rather undeveloped state of cost-benefit analyses in the health area and by some of the problems that will have to be overcome before useful analyses can be done on many of the problems. However, it seems likely to me that with the U.S. government's increasing role in the health field that the payoff to good analysis will be very large.